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COMPOSITION, APPARATUS, AND METHOD OF CONDITIONING SCALE ON A METAL SURFACE

CROSS REFERENCE TO RELATED APPLICATION

This application is a divisional of application Serial No. 09/469,687, filed December 22,1999, now US 6,450,183.

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FIELD OF THE INVENTION

This invention relates generally to conditioning of oxide or scale on a metal surface; more particularly on a strip of metal, and yet more particularly, to conditioning of oxide surfaces or scale on a stainless steel strip. Stainless steels are ferrous alloys containing more that about 10% chromium for the purpose of enhancing corrosion and oxidation resistance. Some stainless steels also contain nickel, molybdenum, silicon, manganese, aluminum, carbide formers and other elements. This invention is also applicable to families of alloys including superalloys where nickel is the predominant element, titanium alloys and cobalt alloys. In even more particular aspects, this invention relates to aqueous spray conditioning.

BACKGROUND OF THE INVENTION

Descaling of metal strip, especially stainless steel strip, has taken many forms in the past. The simplest technique involves only the pickling of the strip in mineral acid such as sulfuric acid, hydrochloric acid, hydrofluoric acid, nitric acid, or mixtures thereof. This may work with some grades of stainless steel with very light scale; however, in most cases more is needed than just an acid pickle. In those cases, various compositions and techniques have been developed to condition the scale before acid pickling. Typical compositions for scale conditioning include mixtures of alkali metal hydroxides and alkali metal nitrates with various other additives, such as alkali halides, carbonates, and/or other oxidizing agents. These are often referred to as descaling or scale conditioning salts. A conventional technique for using such compositions is in the fused anhydrous state in a pot at elevated temperatures, e.g. 800°F to 1000 °F, through which the strip is passed, followed by an acid pickle. While this works well in many cases, nevertheless there are certain drawbacks to this technique in some instances. For example, the bath has to be maintained at elevated temperatures, which may be energy

VERSION OF CLAIMS WITH MARKINGS TO SHOW CHANGES

1. A system for conditioning scale on the surface of a metal object comprising:

   at least one nozzle adapted to spray droplets of an aqueous caustic solution;

   at least one reservoir for containing said aqueous caustic solution communicating with said at least one nozzle;

   a driving mechanism positioned to move the metal object relative to said at least one nozzle;

   a temperature-sensing device positioned to sense the temperature of the surface of said metal object prior to the metal object passing said at least one nozzle,

   a ~~cooling~~ <u>temperature modifier</u> mechanism adjacent said temperature-sensing device, and

   a control mechanism to control said ~~cooling~~ <u>temperature modifier</u> mechanism responsive to the sensed temperature of the surface of said metal object <u>to a temperature above the melting point of the composite contained in the aqueous solution and below the temperature at which the Leidenfrost effect appears</u>.

2. The system as defined in claim 1 wherein there is at least a second reservoir for a fluid communicating with said at least one nozzle and with said control mechanism.

3. The system as defined in claim 1 wherein there is at least a second nozzle adapted to spray droplets of a solution communicating with said reservoir, and with said control mechanism.

4. The system as defined in claim 1 wherein the control mechanism includes flow control devices to control the flow individually from each reservoir to said nozzle.

5. The system as defined in claim 1 wherein said metal object is a metal strip.

6. The system as defined in claim 5 wherein there is at least one nozzle disposed on each side of said strip.

7. The system as defined in claim 1 wherein an acid pickling station is provided.

8. The system as defined in claim 1 wherein the ~~control is configured to control the cooling device to cool the surface of the metal object to a temperature above the melting point of the composition contained in the aqueous solution and below the temperature at which the Leidenfrost effect appears~~ temperature modifier mechanism is a cooling mechanism.

9. The system as defined in claim 5 further characterized by a surface coverage analyzer adjacent said at least one nozzle.

10. The system as defined in claim 1 wherein there is a speed sensing device to sense the speed of said metal object, and said control device is configured to vary the flow of said aqueous caustic solution responsive to the sensed speed of the metal object.

11. A method of treating scale on the surface of a metal object comprising the steps of:

a) providing a metal object with scale thereon;

b) providing an aqueous solution comprised of an alkali metal hydroxide or mixture of alkali metal hydroxides;

c) controlling the temperature of the surface of the metal object to a temperature above the melting point of the alkali metal hydroxide or hydroxides in anhydrous form and where conditioning occurs, and below the temperature at which the Leidenfrost effect appears; and

d) spraying said solution on the surface of the metal object, wherein the step of spraying said solution on the surface of the metal object is performed in an oxidizing atmosphere.

~~12. The method as defined in claim 11 wherein the solution contains sodium~~

~~hydroxide or potassium hydroxide or a mixture thereof.~~

~~13. The method as defined in claim 11 wherein the metal is acid pickled after spraying with said solution.~~

~~14. The method of claim 11 wherein the concentration of the solution is between about 15% and 65% solids by weight.~~

~~15. The method as defined in claim 11 wherein the solution concentration is between about 35% and 45% solids by weight.~~

~~16. The method as defined is claim 11 wherein the concentration of the solution is about 40% solids by weight.~~

~~17. The method as defined in claim 11 wherein the temperature of the surface of the metal object is at least about 450°F, and does not exceed about 700°F.~~

~~18. The method as defined in claim 14 wherein the temperature of the surface of the metal object is at least about 450°F and does not exceed about 600°F.~~

~~19. The method as defined in claim 11 wherein the metal is stainless steel strip.~~

~~20. The method of claim 11 wherein the solution contains an effective amount of an additive selected from the group of alkali metal carbonates, alkali metal chlorates, alkali metal nitrates, alkali metal permanganates, and mixtures thereof.~~

~~21. The method of claim 20 wherein the additive is an alkali metal permanganate.~~

~~22. The method of claim 12 wherein aqueous solution is comprised of a eutectic mixture of sodium hydroxide and potassium hydroxide.~~

23. An aqueous solution comprised of a mixture of sodium hydroxide and potassium hydroxide, wherein there is between about 15% and about 65% solids by weight.

24. The solution as defined in claim 23 wherein there is between 35% and 45% by weight solids.

25. The solution as defined in claim 23 wherein there is about 40% by weight solids.

26. The solution as defined in claim 23 wherein the mixture of sodium hydroxide and potassium hydroxide is a eutectic mixture.

27. The solution as defined in claim 23 further characterized by an effective amount, up to about 1% by weight of solids of an alkali metal permanganate.

28. The solution as defined in claim 27 wherein the alkali metal permanganate is potassium permanganate.

~~29. The method of claim 11 wherein the step of spraying said solution on the surface of the metal object is performed in an oxidizing atmosphere.~~

30. The system of claim 4 wherein:
   a) the metal object has a composition and dimensions; and
   b) the control mechanism flow control devices control said flow responsive to at least one of the group consisting of the composition and the dimensions of said metal object.

31. The system of claim 10, wherein:
   a) the metal object has a composition and dimensions; and
   b) the control mechanism flow control devices control said flow responsive to at least one of the group consisting of the composition and the dimensions of said metal object.

32. A system for conditioning scale on the surface of a metal object comprising:

a first reservoir containing an aqueous caustic solution;

a second reservoir containing a second liquid solution;

at least one nozzle communicating with said first and second reservoirs and adapted to spray an atomized mist of a treatment mixture of said aqueous caustic solution and said second liquid solution and thereby cause the treatment mixture to engage the surface of the metal object, said treatment mixture having a concentration of the aqueous caustic solution and a concentration of the second liquid solution;

a driving mechanism positioned to move the metal object at a rate relative to said at least one nozzle and thereby passing said at least one nozzle; and

a control mechanism in communication with said at least one nozzle, the control mechanism configured to control the flow rate of said treatment mixture through said at least one nozzle as an atomized mist engaging said metal object surface .

33. The system of claim 32, wherein the metal object has a surface temperature, further comprising:

a temperature-sensing device in communication with said control mechanism and positioned to sense the surface temperature of said metal object prior to the metal object passing said at least one nozzle;

a temperature control system in responsive communication with said control mechanism and positioned to increase or decrease the temperature of said metal object prior to the metal object passing said at least one nozzle;

wherein said control mechanism directs the temperature control system to increase or decrease the surface temperature of said metal object prior to the metal object surface engaging said atomized treatment mist responsive to the temperature-sensing device.

34. The system of claim 33, wherein the atomized treatment mixture comprises at least one salt having a melting point, and wherein the control mechanism is configured to direct the temperature control system to increase or decrease the surface temperature

of said metal object prior to the metal object surface engaging said atomized treatment mist to a temperature above said salt melting point and below the temperature at which the Leidenfrost effect appears on said metal object surface.

35. The system of claim 34 wherein the atomized treatment mixture mist engages the surface of the metal object in an oxidizing atmosphere.

36. The system of claim 35, further comprising a surface analyzer in communication with said control mechanism and positioned to measure a degree of surface conditioning of said metal object surface after said surface has been engaged by said atomized treatment mist, wherein the control mechanism is further configured to control the flow rate of said treatment mixture through said at least one nozzle responsive to the degree of surface conditioning measured by the surface analyzer.

37. The system of claim 36, further comprising a speed sensing device in communication with said control mechanism and positioned to measure the rate at which said metal object surface passes said at least one nozzle, wherein the control mechanism is further configured to control the flow rate of said treatment mixture through said at least one nozzle responsive to the speed sensing device.

38. The system of claim 32, further comprising:

a flow monitor in series with the at least one nozzle configured to monitor the flow of the treatment mixture through said nozzle, said monitor communicating with the control mechanism; and

at least a second nozzle in communication with said control mechanism and said first and second reservoirs and adapted to spray an atomized mist of a treatment mixture of said aqueous caustic solution and said second liquid solution and thereby cause the treatment mixture to engage the surface of the metal object;

wherein said control mechanism operates said second nozzle responsive to said flow monitor.

39. The system of claim 38 wherein the control mechanism is furthered configured to operate said second nozzle responsive to the degree of surface conditioning measured by the surface analyzer.

40. The system of claim 5 further comprising a surface condition analyzer in communication with said control mechanism and positioned to measure a degree of surface conditioning of said metal strip after said strip has been engaged by the spray droplets, wherein the control mechanism is further configured to control a flow rate of said aqueous caustic solution through said at least one nozzle responsive to the degree of surface conditioning measured by the surface analyzer.

~~41. The method of claim 11, further comprising the steps of:~~

~~providing a composition and dimensions for the metal object; and~~

~~controlling the amount of the solution sprayed on the surface of the metal object;~~

~~wherein the step of controlling the amount of the solution sprayed is responsive to at least one of the composition and the dimensions of the metal object.~~

~~42. The method of claim 41, further comprising the step of analyzing the sprayed metal object surface to measure a degree of surface conditioning of said metal object surface; and wherein the step of controlling the amount of the solution sprayed is further responsive to the step of analyzing said sprayed metal object surface.~~

43. The system of Claim 8 further comprising a heating mechanism disposed to heat the surface of the metal object prior to the metal object passing said temperature-sensing device to a temperature above the melting point of the composition contained in the aqueous solution.

44. The system of claim 32, wherein the metal object has a composition, and wherein the control mechanism is further configured to vary the concentration of said first aqueous caustic solution and vary the concentration of the second liquid solution within said treatment mixture responsive to the composition of said metal object.

45. The system of claim 36, wherein the metal object has a composition and dimensions, and wherein the control mechanism is further configured to vary the concentration of said first aqueous caustic solution and vary the concentration of the second liquid solution within said treatment mixture responsive to at least one of the group consisting of the composition of said metal object, the dimensions of said metal object, and the degree of surface conditioning measured by the surface analyzer.

__VERSION OF ABSTRACT WITH MARKINGS TO SHOW CHANGES__

COMPOSITION, APPARATUS, AND METHOD OF CONDITIONING SCALE ON A METAL SURFACE

ABSTRACT OF THE DISCLOSURE

A composition and apparatus and method ~~of using the composition~~ for aqueous spray ~~descaling or~~ conditioning of scale ~~or oxide~~ on metal surfaces~~, especially stainless steel strip or the like, in one embodiment, although it can be used to descale or condition oxide or scale on other work pieces such as metal bar, or even discrete objects~~. An aqueous solution having a base composition of an alkali metal hydroxide~~, such as sodium hydroxide, potassium hydroxide, or a mixture of alkali metal hydroxides such as sodium hydroxide and potassium hydroxide~~ is used. The aqueous solution may contain ~~certain~~ additives to improve the ~~descaling~~ performance of the salt. In one embodiment, the solution is used to condition the scale ~~or surface oxide~~ on a strip of stainless steel. The strip of steel is at a temperature between the melting point of the alkali metal hydroxide in anhydrous form and a temperature at which the Leidenfrost effect appears. One or more nozzles is provided to spray the solution, and the heated strip is passed by the nozzle or nozzles where the solution is sprayed on the surface or surfaces of the strip that have the scale or oxide. The invention also includes the apparatus and control thereof for the spraying of the solution.